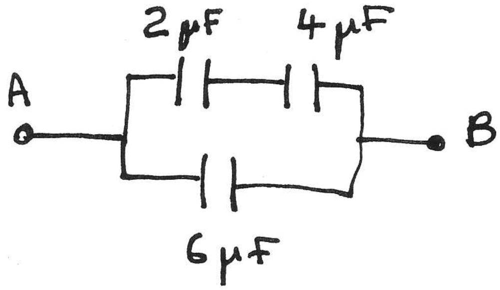
College Physics 2

This quiz is worth 10 points

Quiz # 1

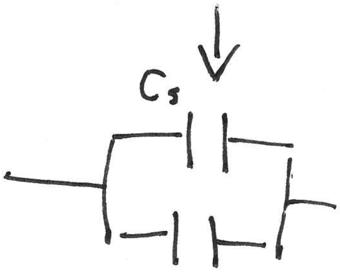
September 11, 2009

1. Three capacitors are connected as shown in the diagram

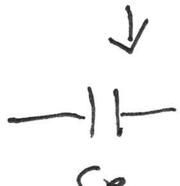


(i) find the equivalent capacitance

(ii) calculate the charge on and the potential difference across the 4μF capacitor if a potential difference of 24V is applied between points A and B.



$$\frac{1}{C_s} = \frac{1}{2\mu F} + \frac{1}{4\mu F} = \frac{3}{4\mu F} \rightarrow C_s = \frac{4}{3}\mu F$$



$$C_p = 6\mu F + C_s = 7\tfrac{1}{3}\mu F$$

Charge on plates of $C_s \Rightarrow q_s = C_s V = \left(\frac{4}{3}\mu F\right)(24V) = 32\mu C$

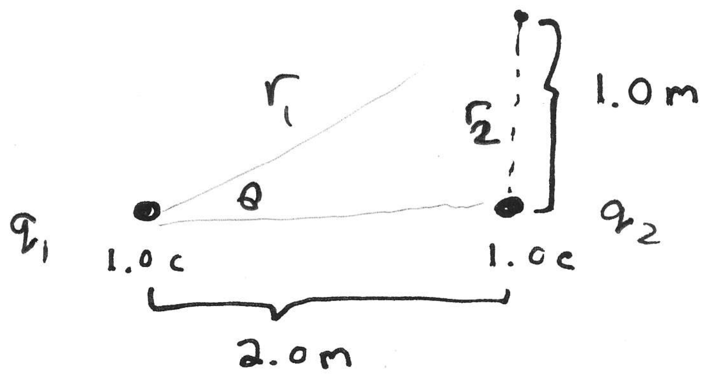
this must also be the charge on the plates of the 2μF and 4μF capacitors.

∴ pot'l diff across 4μF capacitor $\Rightarrow q = CV \rightarrow V = \frac{q}{C}$

so $V = \dfrac{32\mu C}{4\mu F} = 8V$

2. Two charges of + 1.0 C are placed 2.0 m apart on a horizontal line. Find the electric field (magnitude and direction) at a point 1.0 m above the right most 1.0 C charge. What force would a − 2.0 C charge experience at the point where you calculated the electric field $\vec{E}$?

$\tan\theta = \frac{1}{2} \rightarrow \theta = 26.565°$



$1^2 + 2^2 = 5 = r_1^2$

so field due to q_2, $E_2 = \frac{k q_2}{r_2^2} = \frac{(9\times10^9)(1)}{1^2} = 9\times10^9$ V/m

$\vec{E}_2 = 9\times10^9 \hat{j}$ V/m i.e. field in +y direction

$E_1 = \frac{k q_1}{r_1^2} = \frac{(9\times10^9)(1)}{5} = 1.8\times10^9$ V/m, $\vec{E}_1 = 1.8\times10^9$ V/m along r_1

$E_{1x} = |\vec{E}_1| \cos\theta = 1.61\times10^9$ V/m $E_{1y} = |\vec{E}_1| \sin\theta = 0.80\times10^9$ V/m

$\therefore E_x = E_{1x} + E_{2x} = 1.61\times10^9$ V/m

$E_y = E_{1y} + E_{2y} = 9\times10^9 + 0$ $9\times10^9 + (0.8\times10^9) = 9.8\times10^9$ V/m

$\therefore E = \sqrt{E_x^2 + E_y^2} = 9.93\times10^9$ V/m

direction $\theta = \tan^{-1}\frac{E_y}{E_x} = \frac{9.8\times10^9}{1.61\times10^9} = 80.67°$, i.e. 80.67° above (+) x axis

Force on charge $|\vec{F}| = |q||\vec{E}| = (-2.0C)(9.93\times10^9) = 1.986\times10^{10}$ N

= opposite to the direction the field points so $\theta = 260.67°$